

**LABORATORY REPORT**

GROUP NUMBER T1

EXPERIMENT NUMBER 3

TITLE: Respiratory System – Respiration &amp; Pulmonary Function

DATE SUBMITTED 10/29/00

**OVERALL GRADE 90/100****ROLE ASSIGNMENTS**

| <u>ROLE</u>             | <u>GROUP MEMBER</u> |
|-------------------------|---------------------|
| FACILITATOR.....        | Alice Y. Wu         |
| TIME & TASK KEEPER..... | David H. Kim        |
| SCRIBE.....             | Mina Wu             |
| PRESENTER.....          | Christopher Hack    |

**SUMMARY OF CONCLUSIONS**

In this experiment, several ventilation and respiratory properties such as time intervals for inspiration and expiration, breath duration, vital capacity, reserve volumes, forced expiratory volume, and maximal voluntary ventilation were measured under different conditions for four subjects. In lesson eight, it was shown that hyper and hypo - ventilation as well as reading and coughing all generally had significant effects on inspiration time, expiration time, and ventilation depth, however, these results varied among the subjects. Some subjects showed that the different methods of breathing had no significant difference compared to eupnea, but most of the subjects **showed significant sensitivity to the breathing methods according to tests of significance. SURELY HYPERVENTILATION SHOWED MUCH DIFFERENCE FROM EUPNEA? IF IT DIDN'T, THAT IN ITSELF WOULD BE REMARKABLE**

In measuring various lung capacities, it was found that the only volume with a significant difference among the subjects tested was vital capacity (4.58L and 3.60L, t-stat 31.992 compared to t-critical of 12.706). No significant difference among the subjects for the other lung volumes was found, however more trials will be needed in order to verify this.

Using the second method, the total lung capacity was found to be 3.70 and 4.78 for AW and CH respectively. Using the equation  $FRC = ERV + RV$ , the average FRC for

AW and CH are 1.94L and 2.40L, respectively. There was a larger deviation from the expected value of FEV/VC during the 0-2 sec interval for both subjects.

YOU GIVE NUMBERS, WHICH IS GOOD, BUT DON'T SAY WHAT THEY MEAN  
SO THE READER HAS NO IDEA OF THE SIGNIFICANCE

GRADE 15/20

**RESULTS**

**LESSON 8:**

**Figure 8.1: Mean Values and Tests of Significance for Total duration and BPM of Eupnea and the three segments (Subjects 1-3)**

|                         | EUPNEA vs.  | Hyper-ventilation | Hyperv. Recovery | Hypo-ventilation | Hypov. Recov. | Coughing | Reading  |
|-------------------------|-------------|-------------------|------------------|------------------|---------------|----------|----------|
| <b>Subject 1 (CK)</b>   |             |                   |                  |                  |               |          |          |
| <b>TOTAL DURATION -</b> |             |                   |                  |                  |               |          |          |
| Mean Values             | 3.563333333 | 0.68              |                  | 3.33             |               |          | 0.66     |
| 95% CI                  | 0.61        | 0.11              |                  | 0.57             |               |          | 0.17     |
| t Stat                  |             | 22.74             |                  | 2.74             |               |          | 23.54    |
| t Crit                  |             | 4.30              |                  | 4.30             |               |          | 4.30     |
| Significant Difference? |             | YES               | N/A              | NO               | N/A           | N/A      | NO       |
| <b>BPM -</b>            |             |                   |                  |                  |               |          |          |
| Mean Values             |             | 88.2352941        |                  | 18.018018        |               |          | 90.90909 |
| t Stat                  |             | 22.74             |                  | 2.74             |               |          | 23.54    |
| t Crit                  |             | 4.30              |                  | 4.30             |               |          | 4.30     |
| Significant Difference? |             | YES               | N/A              | NO               | N/A           | N/A      | NO       |
| <b>Subject 2 (DK)</b>   |             |                   |                  |                  |               |          |          |
| <b>TOTAL DURATION -</b> |             |                   |                  |                  |               |          |          |
| Mean Values             | 3.71        | 0.603333333       |                  | 1.07666667       |               |          | 1.783333 |
| 95% CI                  | 0.76        | 0.08724011        |                  | 0.2007906        |               |          | 0.499512 |
| t Stat                  |             | 14.88             |                  | 15.32            |               |          | 18.37    |
| t Crit                  |             | 4.30              |                  | 4.30             |               |          | 4.30     |
| Significant Difference? |             | YES               | N/A              | YES              | N/A           | N/A      | YES      |
| <b>BPM -</b>            |             |                   |                  |                  |               |          |          |
| Mean Values             |             | 99.4475138        |                  | 55.7275542       |               |          | 33.64486 |
| t Stat                  |             | 14.88             |                  | 15.32            |               |          | 18.37    |
| t Crit                  |             | 4.30              |                  | 4.30             |               |          | 4.30     |
| Significant Difference? |             | YES               | N/A              | YES              | N/A           | N/A      | YES      |
| <b>Subject 3 (AW)</b>   |             |                   |                  |                  |               |          |          |
| <b>TOTAL DURATION -</b> |             |                   |                  |                  |               |          |          |
| Mean Values             | 3.954       | 1.064             | 4.41             | 4.226            | 3.742         | 0.45     | 2.64     |
| 95% CI                  | 0.16        | 0.12              | 0.27             | 0.30             | 0.43          | N/A      | 1.36     |
| t Stat                  |             | 43.47             | -5.98            | -2.82            | 1.47          | N/A      | 2.16     |
| t Crit                  |             | 2.78              | 2.78             | 2.78             | 2.78          | N/A      | 2.78     |
| Significant Difference? |             | YES               | YES              | YES              | NO            | N/A      | NO       |
| <b>BPM -</b>            |             |                   |                  |                  |               |          |          |
| Mean Values             | 15.18       | 56.604            | 16.078           | 14.246           | 30.212        | 133      | 30.212   |
| 95% CI                  | 0.60        | 5.59              | 0.85             | 0.97             | 1.05          | N/A      | 17.55    |
| t Stat                  |             | -22.96            | -1.57            | 3.10             | -1.90         | N/A      | -1.90    |
| t Crit                  |             | 2.78              | 2.78             | 2.78             | 2.78          | N/A      | 2.78     |
| Significant Difference? |             | YES               | NO               | YES              | NO            | N/A      | NO       |

90 BPM IS VERY FAST AND DIFFICULT TO BELIEVE. WHAT WAS THE NORMAL BPM FOR THIS SUBJECT AND WHY ISNT IS GIVEN. YOU MUST GIVE THE VALUES MEASURED, NOT JUST T VALUES AND THE LIKE SINCE MUCH INFORMATION IS CONTAINED IN TYPICAL RANGES FOR VALUES GIVEN IN THE LITERATURE, THE FIRST THING TO DO IS CHECK TO SEE IF THE SUBJECT IS WITHIN SUCH RANGES

**IF SUBJECT 2 BREATHS 15 NORMALLY AND 14 HYPO, SOMEONE IS NOT TRYING**

This figure shows a quick summary of the results of all significance tests conducted on the mean total duration and BPM values between eupnea and the four other different segments. The figure is used to show if there are significant differences in ventilation attributed to the different activities of the different segments.

**Figure 8.2: Mean Values and Tests of Significance for all values taken (Inspiration, expiration, total duration, BPM) of Eupnea versus the three segments (Subject 4 only)**

| <b>Subject 4 (MW)</b>   | <b>EUPNEA vs.</b> | <b>Hyper-ventilation</b> | <b>Hyperv. Recovery</b> | <b>Hypo ventilation</b> | <b>Hypov. Recov.</b> | <b>Coughing</b> | <b>Reading</b> |
|-------------------------|-------------------|--------------------------|-------------------------|-------------------------|----------------------|-----------------|----------------|
| <b>INSPIRATION -</b>    |                   |                          |                         |                         |                      |                 |                |
| Mean Values             | 2.14              | 0.46                     | 2.15                    | 1.68                    | 2.17                 | 0.62            | 1.14           |
| 95% CI                  | 0.30              | 0.04                     | 0.73                    | 0.28                    | 0.42                 | N/A             | 0.46           |
| t Stat                  |                   | 15.39                    | 0.43                    | 2.25                    | 0.09                 | N/A             | 3.76           |
| t Crit                  |                   | 2.45                     | 3.18                    | 2.45                    | 2.78                 | N/A             | 2.45           |
| Significant Difference? |                   | Yes                      | No                      | No                      | No                   | N/A             | Yes            |
| <b>EXPIRATION -</b>     |                   |                          |                         |                         |                      |                 |                |
| Mean Values             | 1.80              | 0.81                     | 1.82                    | 1.69                    | 1.39                 | 0.53            | 0.97           |
| 95% CI                  | 0.17              | 0.07                     | 0.52                    | 0.49                    | 0.53                 | N/A             | 0.27           |
| t Stat                  |                   | 22.10                    | -0.27                   | 0.51                    | 2.67                 | N/A             | 4.41           |
| t Crit                  |                   | 2.45                     | 2.78                    | 2.45                    | 2.78                 | N/A             | 2.45           |
| Significant Difference? |                   | Yes                      | No                      | No                      | No                   | N/A             | Yes            |
| <b>TOTAL DURATION -</b> |                   |                          |                         |                         |                      |                 |                |
| Mean Values             | 3.99              | 1.38                     | 3.62                    | 3.30                    | 3.54                 | 1.10            | 1.14           |
| 95% CI                  | 0.35              | 0.04                     | 0.62                    | 0.44                    | 0.50                 | N/A             | 0.40           |
| t Stat                  |                   | 17.72                    | 1.65                    | 2.39                    | 3.12                 | N/A             | 9.65           |
| t Crit                  |                   | 2.45                     | 2.78                    | 2.45                    | 2.78                 | N/A             | 2.45           |
| Significant Difference? |                   | Yes                      | No                      | No                      | Yes                  | N/A             | Yes            |
| <b>BPM -</b>            |                   |                          |                         |                         |                      |                 |                |
| Mean Values             | 15.16             | 43.77                    | 16.77                   | 18.59                   | 17.06                | 62.13           | 29.10          |
| 95% CI                  | 1.42              | 1.32                     | 2.74                    | 2.66                    | 2.48                 | N/A             | 4.20           |
| t Stat                  |                   | -19.89                   | -1.85                   | -2.24                   | -3.62                | N/A             | -7.20          |
| t Crit                  |                   | 2.45                     | 2.78                    | 2.45                    | 2.78                 | N/A             | 2.45           |
| Significant Difference? |                   | Yes                      | No                      | No                      | Yes                  | N/A             | Yes            |

This figure shows a more thorough analysis of significance among the mean values of all ventilation data collected for the eupnea and the four different segment. It tests for significance of the inspiration, expiration, total duration, and BPM mean values between eupnea and the four other segments. Due to its more detailed nature, it was performed on Subject 4's data only.

**Figure 8.3: Tests of Significance for and Mean Values of Relative Ventilation Depths for all four Subjects**

| Subject | Vent. Depth -<br>Mean Values<br><i>t Stat</i><br><i>t Crit</i><br>Sig. Diff? | EUPNEA vs. | Hyper-<br>ventilation                   | Hyperv.<br>Recovery                 | Hypo-<br>ventilation                       | Hypov.<br>Recov.                    |
|---------|--|------------|---|-------------------------------------|--|-------------------------------------|
| 1 (CK)  |  | 2.06       | 0.89<br>7.56<br>4.30<br>YES             | N/A                                 | 0.45<br>7.07<br>4.30<br>YES                | N/A                                 |
| 2 (DK)  |  | 1.21       | 1.67<br>1.01<br>4.30<br>NO              | N/A                                 | 1.23<br>0.12<br>4.30<br>NO                 | N/A                                 |
| 3 (AW)  |  | 2.45       | 3.87<br>-4.7004309<br>2.77645086<br>YES | N/A<br>N/A<br>N/A<br>N/A            | 1.16<br>3.186596323<br>2.776450856<br>YES  | N/A<br>N/A<br>N/A<br>N/A            |
| 4 (MW)  |  | 3.99       | 4.07<br>-11.798962<br>2.44691364<br>YES | 4.01<br>-0.362701<br>2.776451<br>NO | 3.011<br>6.312034575<br>2.776450856<br>YES | 3.95<br>-0.362701<br>2.776451<br>NO |

## LESSON 12:

**Figure 12.1: Measured respiratory volumes for two subjects**

| Subject | Volume Titles         | average  | 95% CI   | Dev from<br>Literatur<br>e |
|---------|-----------------------|----------|----------|----------------------------|
| CH (M)  | Tidal Vol (TV)        | 0.62239  | 1.000228 | 37.01855<br>35             |
|         | Insp. Res. Vol. (IRV) | 1.66184  | 0.876597 |                            |
|         | Exp. Res. Vol. (ERV)  | 1.79568  | 1.957891 |                            |
|         | Vital Capacity (VC)   | 4.00562  | 0.172804 |                            |
| AYW (F) | Tidal Vol (TV)        | 0.92108  | 1.143554 | 19.64161<br>29             |
|         | Insp. Res. Vol. (IRV) | 0.831295 | 0.295863 |                            |
|         | Exp. Res. Vol. (ERV)  | 0.84401  | 0.183858 |                            |
|         | Vital Capacity (VC)   | 2.49111  | 0.774313 |                            |

**YOU REALLY DON'T THINK ALL THOSE FIGURES ARE SIGNIFICANT?**

In the chart above, tidal volume is measured as the maximum (peak-to-peak) difference between normal inhalation volume and normal exhalation volume over three breaths.

Inspiratory respiratory volume (IRV) is measured as the difference between maximum inhalation volume and normal inhalation volume *for one breath* (the last breath taken before test for maximum inhalation).

Expiratory respiratory volume (ERV) is measured as the difference between maximum exhalation volume and normal exhalation volume *for one breath* (the last breath taken before test for maximum exhalation).

Vital capacity (VC) is measured as the difference between the maximum inhalation and the maximum exhalation volumes. VC is roughly equal to TV + IRV + ERV. It is not exactly equal in the chart above because both IRV and ERV for each trial is the measurement for difference between maximum and the last breath before test (as explained in paragraphs above).

**Figure 12.2: Calculated respiratory capacities for two subjects**

| Subject          | Capacity                  | Formula    | Average | 95% CON  |          |
|------------------|---------------------------|------------|---------|----------|----------|
| CH (M)           | Inspiratory (IC)          | IC=TV+IRV  | 2.28423 | 5        |          |
|                  | Expiratory (EC)           | EC=TV+ER   |         | 0.957662 |          |
|                  |                           | V          | 2.41807 | 6        |          |
|                  | Functional Residual (FRC) | FRC=ERV+RV |         | 4.395184 |          |
|                  |                           | TLC=IRV+TV | 2.29568 | 5        |          |
| Total Lung (TLC) | +ERV+RV                   | 4.57991    | 9       |          |          |
| AYW (F)          | Inspiratory (IC)          | IC=TV+IRV  | 1.75237 | 0.847690 |          |
|                  | Expiratory (EC)           | EC=TV+ER   |         | 5        |          |
|                  |                           | V          | 1.76509 | 5        |          |
|                  | Functional Residual (FRC) | FRC=ERV+RV |         | 1.84401  | 0.183858 |
|                  |                           | TLC=IRV+TV |         | 3.59638  | 0.663832 |
| Total Lung (TLC) | +ERV+RV                   |            | 5       | 8        |          |

The capacities for each subject as shown above is calculated from the respiratory volumes in Fig xx with the formula given. Residual volume (RV), since it cannot be measured, is assumed to be 1.2 liter for males and 1.1L for females.

**Figure 12.3: Paired t-test for two means across respiratory volumes / capacities for two subjects**

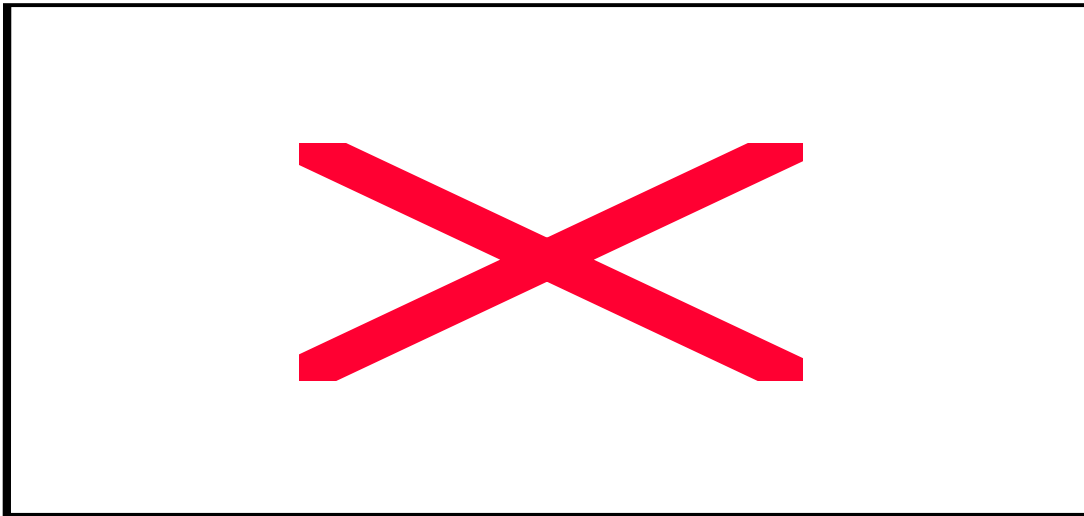
| Paired t-test for two means (comparison between two subjects) |        |
|---|--------|
| Tidal Vol (TV)  | 6.5665 |
| Insp. Res. Vol. (IRV)   | 4.2372 |
| Exp. Res. Vol. (ERV)  | 1.2533 |

|                           |         |
|---------------------------|---------|
|                           | 31.9921 |
| Vital Capacity (VC)       | 8       |
| Inspiratory (IC)          | 6.567   |
| Expiratory (EC)           | 4.3272  |
| Functional Residual (FRC) | 1.2533  |
| Total Lung (TLC)          | 2.2283  |

*t-critical: 12.7061505*

### **LESSON 13:**

**Figure 13.1: Comparison of FEV (x)% to normal values**

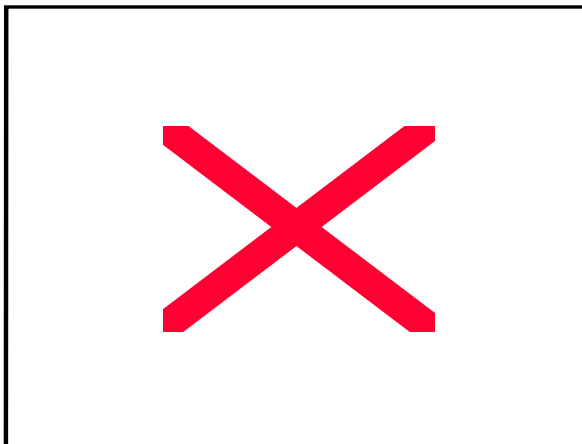


In the above chart subjects AW and CH exhaled as quickly as possible after inhaling as much air as possible

The FEV is the forced expiratory volume is a measure of *peak to peak* for given time intervals. The time intervals are: 0-1sec, 0-2sec, 0-3sec for each of which the FEV, and VC (vital capacity) are measured.

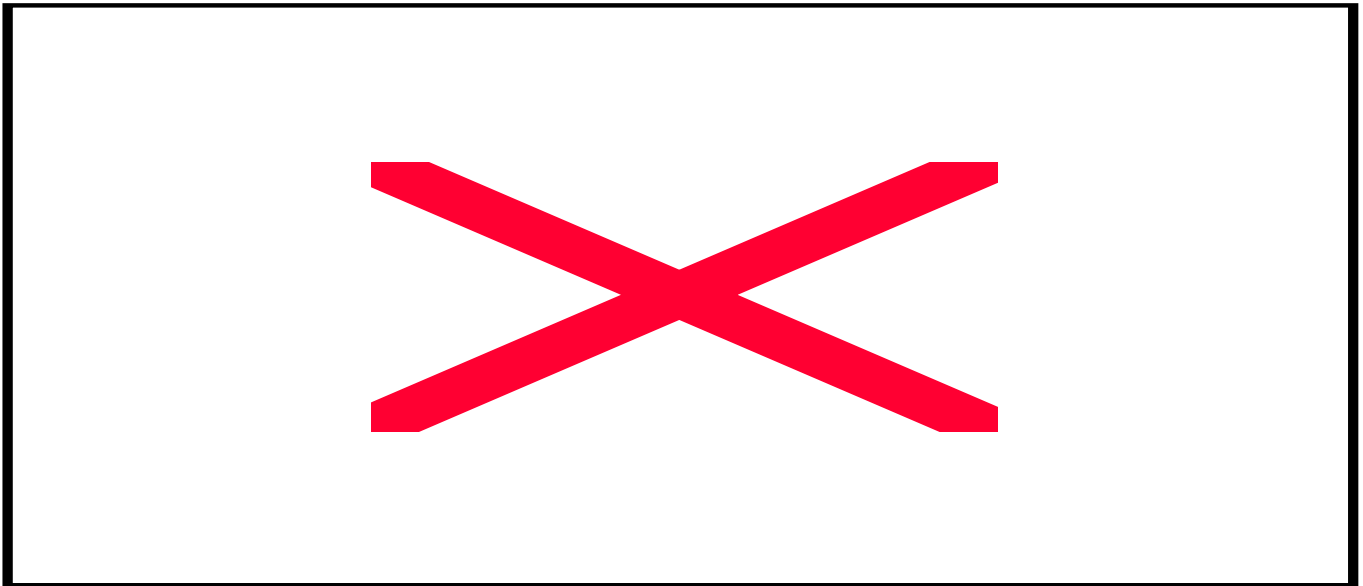
The ratio for FEV/VC is the FEV of that particular interval. Expressed as a percentage, it can be compared to reference values.

**Figure 13.1a: further analysis of FEV values**



This table shows the average FEV values, the standard deviation of these values, the calculated vital capacity, and the average FEV/VC percentage for each trial.

**Figure 13.3: MVV measurements**



breathing

The AVPC (average volume per cycle) is the sum of all the cycles in the twelve-second interval divided by the total number of cycles.

The MVV is the AVPC multiplied by the respiratory cycles per minute (RR), which is found by multiplying the number of cycles per minute in the 12 second interval by 5.

**GOOD RESULTS PRESENTATION EXCEPT FOR BUNGLED GRAPHS  
GRADE 40/40**

## **ANALYSIS**

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### **LESSON 8:**

The duration of a breath and the ventilation rate, BPM, (Breaths per minute) was determined to vary depending on the four different segments of eupnea, hyperventilation, hypoventilation, and reading, for each subject. According to Figure 8.1 which shows the

Paired Mean t-tests of the four segments, both the total time duration and BPM values for hyperventilation and hypoventilation was shown to be significantly different from their respective values during eupnea. For subject 3 (AW), the duration of a breath in eupnea was  $3.954 \pm .16$  seconds (95% CI) while duration during hyperventilation was significantly less at  $1.064 \pm .12$  s (95% CI) and hypoventilation was significantly more at  $4.226 \pm .30$  s (95% CI). Comparison of the BPM values of Subject 3 also yielded significant differences; where the BPM during eupnea was  $15.18 \pm .60$  s (95% CI) while hyperventilation BPM was significantly larger at  $56.604 \pm 5.59$  (95% CI) and hypoventilation BPM was significantly less at  $14.246 \pm 14.246$  s (95% CI). **WHY ARE YOU RETELLING ME WHAT IS SHOWN IN THE RESULTS-ANALYZE THEM!** These values agree with the logic behind ventilation mechanics. Hyperventilation consists of **deeper,?? ?** quicker breaths thereby yielding shorter durations of breaths but more breaths in a minute (faster rate). Hypoventilation works in the opposite way, consisting of slower, **shallower????** breaths thereby causing longer duration but less BPM (slower rate). **WONT QUICKER BREATHS BE SHALLOW AND SLOW BREATH BE DEEP?Comparison** of eupnea with the recovery stages of hyperventilation and hypoventilation showed no significant differences except for breath duration during hyperventilation recovery. In this case, breath duration of hyperventilation recovery was significantly larger at  $4.41 \pm .27$  s (95% CI) when compared to eupnea breath duration, which lasts  $3.954 \pm .16$  s (95% CI). This can be explained by the fact that after a period of quick, deep breathing, the body rids carbon dioxide faster than it produces thereby elevating pH levels.**EVEN IF THIS WERE TRUE, WHAT MEASURED RESULTS DOES IT EXPLAIN AND WHY?** During recovery, the body will tend to negate the effects of hyperventilation by elongating breath duration and slowing BPM until normal conditions are restored. Subject three showed no significant differences in either breath duration or BPM when reading as compared to eupnea. **SO WHAT**

For subject 4 (MW), additional comparisons of inspiration and expiration durations were also made, in addition to total duration and BPM, in order to offer more insight into the mechanics of ventilation. The only significant differences in inspiration and expiration values for this subject was found between eupnea and hyperventilation and eupnea and reading. Hyperventilation and reading inspiration durations were both found to be significantly less than during eupnea ( $.46 \pm .04$  s [95% CI] for hyperventilation,  $1.14 \pm .46$  s [95% CI] for reading, versus  $2.14 \pm .30$  s [95% CI] for eupnea). The expiration duration values (Figure 8.2) for hyperventilation and reading were also shown to be significantly less. Total breath duration and BPM values were significantly different from eupnea only in the cases of hyperventilation, hypoventilation recovery, and reading. Breath duration for all three cases were significantly less than that of eupnea (figure 8.2). BPM values for hyperventilation, hypoventilation recovery, and reading were significantly greater than during eupnea. The values of hyperventilation and hypoventilation recovery makes sense against that of eupnea by the same reasoning used above to explain Subject 3's results.

One noticeable trend in Subject 4's results is that there were no significant differences in any of the four values (inspiration, expiration, total duration, and BPM) between eupnea and the case of hypoventilation. The trials of the other subjects, such as subject 3, did show significant differences in these values between eupnea and hypoventilation. For example, for subject 3, hypoventilation breath duration was significantly larger than that of eupnea and **BPM values for hypoventilation were significantly greater than eupnea??????** This goes in accordance with the reasoning that slower breathing rates will produce longer, more drawn out breaths which, in effect, will lower the BPM (rate of breathing). **YOU SAID GREATER JUST NOW** Therefore, a conclusion to be drawn is that the subject did not perform the hypoventilation correctly. **WHO WAS THE DIRECTOR? YOU TELL THE SUBJECT TO BREATHE SLOWER THAN BEFORE AND IF HE DOESN'T, YOU TELL HIM AND DO IT UNTIL HE GETS IT RIGHT. THE DIRECTOR SHOULD BE FIRED!** However, significance tests of the ventilation depths between eupnea and hypoventilation show differences (Figure 8.3). Ventilation depth is significantly greater for eupnea than for hypoventilation. Since breathing rate and depth are within subject's control, this implies that the subject **failed to slow down her rate but did take shallower breaths during hypoventilation. MAYBE SHE SHOULD HAVE TAKEN SLOWER AND DEEPER- ISNT THAT EASIER?**

Another interesting activity which showed great variances among the four subjects was the act of reading. For certain subjects, such as subject 4, it produced definite significant differences between eupnea and the four different activities for all the values (inspiration, expiration, total duration, and BPM). For others, such as subject 3, there were no differences in any of the values collected. (Figure 8.1) For subject 4, the inspiration, expiration, and total duration time for reading were all significantly less than that during eupnea while the BPM during breathing was significantly greater. These values can be explained by the phenomenon which occurs during speaking. An explanation for why inspiration, expiration, and total duration times are shortened are due to fact that during reading, people will take quick draws of breaths in order to interrupt their reading as least as possible. This causes the inspiration and total duration time to be significantly shorter. However, carbon dioxide is expelled as the person reads, thereby requiring more breaths in order to maintain a normal level of carbon dioxide and pH within the body. This results in the decreased expiration time and increased BPM value for reading. However, for subject 3, neither the total duration time nor the BPM were significantly different from that during eupnea. This subject obviously reads differently than from subject 4. For subject 3, the activity of reading evidently does not interrupt subject's normal eupnea pattern as much as it does for subject 4. Therefore, no significant differences are created for any of the values taken.

Another interesting phenomenon which has an effect on ventilation rate and behavior is coughing. Coughing involves a rapid intake and expelling of a quantity of air. The effects of coughing in this lab can only be observed and analyzed quantitatively

due to lack of trials. In all four subject's cases, the total duration of the coughs was noticeably shorter than that during eupnea due to the rapid intake and expelling of air. The BPM of coughing for all four subjects were also much greater than that during eupnea. In the case of subject 4, the BPM value of coughing was 133 breaths per minute. The BPM for coughing was determined by translating the total duration time of a breath during coughing into a rate of breaths per minute. Since a cough is so quick and lasts for such a short duration, it should undoubtedly yield a very large value for BPM if it were performed regularly, nonstop.

## **LESSON 12:**

In this study, the two subjects are a twenty-year-old male with excellent fitness (CH) and a twenty-year-old female who does not maintain a regular exercise schedule (AYW). In the comparison of the lung volumes and capacities for each subject, it can be seen that while the vital capacity between the subjects is significantly different (t-stat 31.992 compared to t-critical of 12.706), all other volumes and capacities are not significantly different.

Vital capacity is dependent on factors such as age, height, sex difference, and other factors such as physical health. Since subject CH and AYW are of the same age, their significant difference in vital capacity is very likely due to the difference in height, sex difference, and physical fitness levels.

Surprisingly, a significant difference is not seen in the comparison for total lung capacity (TLC), as we would expect it to be since TLC is dependent largely on vital capacity. On closer inspection, it can be seen that the TLC values for the two subjects are 4.57991 and 3.59638, respectively. However, TLC value is obtained by adding the values of vital capacity (or, the sum of IC, EC, and FRC) and RV (Residual Volume). Using this apparatus, the residual volume (RC) cannot be measured, and thus is assumed to be 1 liter by default. In effect, the 1liter RV value by default makes up 21.83% and 27.81% of the total lung capacity, respectively. Thus, in each subject the addition of default 1liter to determine the TLC sways the t-statistic from 31.99 (without the 1 liter) to 2.2283.

### **GOOD POINT**

The fact that the other volumes and capacities are not significantly different between the subjects is very likely a result of the large 95% CI interval in subject CH's data, which are seen to be actually larger than the volume itself in certain cases (IC is  $0.62239 \pm 1.00023L$ , and ERV is  $1.79568 \pm 1.957891 L$ ).

A surprising observation that can be seen in the data is that while CH has greater lung capacity than AYW, his tidal volume is actually smaller. We might expect that CH has greater lung capacity because he is a male, taller, and more fit than AYW, but this expectation is not supported by the data. This observation can be explained by a number

of things, including 1) subject CH reported to be self-conscious during the experiment, which might have caused him to take more shallow breaths, and 2) AYW has played a wind instrument before while CH has not, which might have trained to take AYW to take deeper breaths in general, and thus would have greater tidal volume.

### **LESSON 13:**

When measuring Forced Expiratory Volume (FEV), and Maximal Voluntary Ventilation (MVV) the results are very vulnerable to both the physiology of the subject, as well as the sensitivity of the equipment and the manner in which the experiment is conducted. At times it is difficult to obtain normal breathing reading because when a subject is aware of his breathing he tends to alter his natural patterns, taking breaths that are either too shallow or too deliberate.

AW, a 5-foot tall female, has a much lower total lung capacity than CH who is 6 feet tall and male. Assuming the residual value is 1.2 liters for males and 1.1 L for females, and by summing up the Inspiratory Reserve Volume, the Expiratory Reserve Volume, Residual Volume, and the Tidal Volume, the total lung capacity can be calculated. For AW the total lung capacity is calculated in the first trial to be 3.74863L, and in the second trial as 3.64414L.

For CH the total lung capacity is 5.27353L for the first trial and 4.28629L for the second. Therefore, the average lung capacity for AW and CH is 3.696385L and 4.77991L respectively. All of this takes in account that the residual volume, the amount of air left in the lung, is equivalent to 1.2L or 1.1L. Using the same assumption for RV, the Functional residual Capacity is calculated with the following equation:  $FRC = ERV + RV$ . The average FRC for AW is 1.94401L and for CH it is 2.39568L.

The expected values for the forced expiration volume and those values that were actually measured differ from the references values the most in the first times interval of 0-1 sec. The FEV/ VC ratio for the time interval of 0-1sec is 83%, however for CH the value was 48.96% in the first trial and 72.504 in the second trial. For AW the FEV/VC ratio was 40.50% in the first trial, and 36.01% in the second trial. The value for CH's and AW's first trial 48.96% and 40.50% respectively, is probably low because the subjects did not properly follow the procedures and exhale fully quickly enough. But instead they began to exhale slowly, and as the numbers indicate, they exhale at an increasingly faster rate as the time goes from 1-3sec.

For the 0-2sec interval the expected value for the FEV/VC ratio is 94%. For CH the value was 81.24% for the first trial and 100% for the second trial. For AW her values for the second interval are 76.55% and 71.217% for the first and second trails respectively. While the expected value for the third trial is 97%, meaning that after maximum exhalation there should still be air left in the lungs 3%, both CH and AW exhaled 100% by the third second. If however air should remain after maximum exhalation then the equipment was not sensitive enough to detect any remaining air.

Unlike normal breathing, a lot has to account for when dealing with forced maneuvers. One has to consider the relative strength of the lungs of the subjects. CH is athletic and works out almost everyday, while AW had conditioned her lungs by musical instruments, so naturally they would not expel air identically. In addition to their difference in size (about 1foot), the body composition and or course the sex of the subject also accounts for their differences.

**YOU HAVE TOO MANY WORDS AND SEEM TO BE SAYING CONTRADICTORY THINGS THAT ARE CONFUSING, BUT IT SHOWS GOOD UNDERSTANDING IF SOMEWHAT LACKING IN EFFECTIVE TRANSMISSION**

**GRADE 35/40**